

**State of California
AIR RESOURCES BOARD**

**Research Screening Committee Meeting
Cal/EPA Headquarters Building
1001 I Street
Conference Room 510, 5th Floor
Sacramento, California 95814
(916) 445-0753**

**March 9, 2012
9:00 a.m.**

ADVANCE AGENDA

- I. Corrections to the minutes of the October 28, 2011 meeting and minutes of the December 2, 2011 meeting
- II. Discussion of a Response to a Request for Proposals:
 - 1) "Investigate the Durability of Diesel Engine Emissions Controls," RFP No. 11-309
 - University of Denver
Proposal No. 2734-273, \$289,678

Introduction of new engine emissions standards for particulate matter (PM) and oxides of nitrogen (NO_x) will result in a substantial decrease of these pollutants over the course of the next several years. This reduction is generally achieved by using aftertreatment devices such as diesel particulate filters and selective catalytic reduction to reduce PM and NO_x respectively. The Air Resources Board's (ARB) recently revised fleet rules will lead to gradual introduction of these technologies on California highways and ports, thereby reducing emissions from diesel engines.

While various studies have been performed to assess the efficiency of these devices, so far minimal data exists on durability and deterioration. The primary reason for limited data includes fairly recent introduction of these devices along with the challenges related to sampling thousands of trucks over a course of multiple years. The available data is especially sparse in terms of PM measurement and has often utilized technologies that don't measure PM directly. In essence, while the available data can demonstrate fleet emission changes due to improvement in engine technology, it does not provide a good understanding of emission changes related to the introduction of aftertreatment devices over an extended period of time. It is important to measure pollutant concentrations in the real world because trucks with malfunctioning aftertreatment devices could emit

tens to hundreds of times higher emissions than a truck meeting certification standards. Potential aftertreatment failures and related emissions increases would reduce the air quality and health benefits of the new engine standards and also generate inaccurate emission inventories. Additionally, the data generated from this study may provide clues about tampering/mal-maintenance of these devices that could cause increases in pollutant concentrations.

The proposed project will build upon existing databases of on-road measurements (remote sensing, vehicle chase studies, etc.), to provide a comprehensive analysis of pollutant profiles over the course of several years. At a minimum, data will include measurements of criteria pollutants, such as carbon monoxide, total hydrocarbons, black carbon, NO_x, and PM. Particle number and size distribution will also be collected based on instrumentation availability from ARB.

III. Discussion of New Research Projects:

- 1) "Benefits of High Efficiency Filtration to Children with Asthma," University of California, Davis, \$3,350,000, Proposal No. 2735-273

PM and ozone (O₃) levels continue to be elevated in California urban areas, and a number of studies have shown that ultrafine PM is elevated near busy roadways. These pose a significant health issue, because elevated ambient PM and O₃ and near-roadway exposures have been associated with numerous adverse effects, including exacerbation of symptoms in children with asthma. The objectives of this project are to determine the extent to which high efficiency air filtration in homes reduces indoor exposures to PM and O₃, and whether there is a concomitant reduction in asthma symptoms in children with moderate to severe asthma. Two hundred children will be enrolled for two years to test the effects of central system or portable high efficiency filters or filtration units. It is anticipated that this project will find that both the in-duct and stand-alone high efficiency filtration units will result in reduced indoor air pollution and a lower prevalence of asthma symptoms. As a result of this study, ARB should be able to determine whether these interventions will reduce exposures to key air pollutants and be cost effective in reducing health costs associated with asthma care.

- 2) "Quantification of the Emission Reduction Benefits of Mitigation Strategies for Dairy Silage," University of California, Davis, \$400,000, Proposal No. 2736-273

Recent studies indicate that dairy silage (chopped plants preserved by fermentation) is likely a significant source of volatile organic compounds (VOC) and NO_x, both of which are O₃ precursors. Out of the approximately 1,700 dairy farms in California, more than 80 percent are located in the San Joaquin Valley (SJV), which has been classified as an extreme O₃ nonattainment area. More research is needed to better quantify both the total silage emissions and the various emission species. The proposed research expands upon previous flux chamber measurements (Schmidt, 2009), with additional measurements using Fourier Transform Infrared spectroscopy and wind tunnels. By using multiple

sampling techniques, this research will significantly increase the quantity and quality of data available with a goal of publishing the results in a peer reviewed journal. The project further expands on past work by including emissions measurements through the entire silage management cycle, from the creation of the silage pile to the feeding process. The research will evaluate typical piles at typical dairies (i.e., dairies implementing commonly established measures such as standard chop-size and minimum pile density) and will also quantify reductions from less common practices (such as Ag-bags and feed additives) included as compliance options in the SJV Air Pollution Control District (SJV District) Rule 4570. One other mitigation strategy, water addition, will also be evaluated. The tasks were selected in consultation with the SJV District.

The SJV District currently estimates that silage accounts for at least 60 percent of total dairy VOC emissions. During a recent study on fermentation of alfalfa and corn silage, the Mitloehner research team found that NO_x emissions from silage may be significant, a finding that is supported by previous studies (including Maw et al, 2001). Other studies (including Augusto et al, 2002) have proposed potential biochemical pathways for NO_x formation. The evaluation of the emissions impact from various mitigation strategies will improve quantification of the benefits of the Rule 4570 as well as the overall emissions profile for dairies.

- 3) "Emissions of Potent Greenhouse Gases from Appliance and Building Waste in Landfills," California Polytechnic State University, San Luis Obispo, \$299,826, Proposal No. 2737-273

High-global warming potential (high-GWP) greenhouse gases (GHG) contained in waste insulating foam may potentially be a significant source of GHG emissions, estimated to be upwards of 2.7 million metric tonnes of carbon dioxide equivalents in California in 2010, and expected to increase to 8.2 MMTCO₂E annually by 2020. However, these estimates are uncertain, as no waste foam GHG emissions have been measured from California landfills, and research is necessary to confirm the extent to which waste foam in landfills is biologically attenuated or captured and reduced by landfill gas collection and combustion systems. The objective of this research is to determine the high-GWP GHG emissions from waste insulating foam in landfills. The high-GWP GHGs used as foam expansion agents in insulating foam include chlorofluorocarbons, hydrochlorofluorocarbons, and hydrofluorocarbons, which have high-GWPs ranging from 700 to 4750. Findings from this study will help determine if the business-as-usual process of disposing appliance and building waste foam into California landfills is a significant source of high-GWP GHG emissions and whether there is a need for any action to reduce these emissions to help meet GHG reduction goals of Assembly Bill (AB) 32. This project will also provide sufficient information to verify or assist in revising the foam destruction offset assumptions used in the protocols for ozone-depleting substance destruction programs.

- 4) "Quantifying the Comprehensive Greenhouse Gas Co-Benefits of Green Buildings," University of California, Berkeley, \$180,000, Proposal No. 2738-273

Buildings represent the second largest source of California's GHG emissions when evaluating energy usage alone. Commercial buildings generated 10.8 percent of statewide GHG emissions in 2008. As California moves towards better quantifying GHG emissions reductions associated with energy efficiency improvements in buildings, research is needed to fully account for the GHG emissions reductions associated with related improvements in the water, waste, and transportation components of building projects. The Climate Change Scoping Plan states that further research is needed to quantify these additional GHG emission reductions of green buildings. The objective of this research is to develop a database of certified commercial green buildings in California that includes performance metrics to measure GHG emission reduction co-benefits due to water savings, waste reduction and minimized transportation impacts. This information will be useful in quantifying additional GHG emission reductions beyond energy savings in commercial buildings to assist with meeting the goals of AB 32 and Executive Order # S-03-03.

- 5) "Modeling Household Vehicle and Transportation Choice and Usage," University of California, Davis, \$300,000, Proposal No. 2739-273

The AB 32 Scoping Plan points out that significant reductions in GHG emissions from transportation are necessary to reach the State's GHG reduction goals for 2020 and beyond. ARB is already pursuing passenger vehicle related GHG emissions reductions through AB 1493 (Pavley, 2002), Senate Bill (SB) 375 (Steinberg, 2008), the Low Carbon Fuel Standard, the Advanced Clean Cars (LEV III) regulation, and various vehicle efficiency programs (such as the Tire Pressure Regulation). Additional research is needed to support the successful implementation of several of these programs, particularly SB 375 and Advanced Clean Cars.

Research to support SB 375 and Advanced Clean Cars should illuminate Californians' motivations for, and barriers to, voluntarily adopting lower-emissions transportation behaviors, such as purchasing and using vehicles that are more efficient and/or use alternative fuels, and reducing vehicle miles traveled (VMT). In addition, this research will improve ARB's ability to forecast the future light-duty fleet, and associated emissions, and will also improve ARB's understanding of motivations for low-emissions transportation behavior (such as low vehicle ownership or low VMT) and consumer choices about what vehicle to buy and how much to drive. The project contains two major components that are designed to be complementary by providing insights into low emissions travel and consumer choices using different methodologies and datasets. Insights from the first component will help guide the modeling in the second.

The first major component of the proposed project will focus on understanding the factors that lead some Californians to a small transportation emissions

footprint. It will identify the geographic and demographic characteristics of these low transportation emissions households. The second major component of the proposed project will focus on jointly modeling the consumer decision process about when to buy a vehicle, what type of vehicle to buy, and how much to drive the vehicle. This will allow for a more rigorous evaluation of the effects of policies that influence either the choice of vehicle or the usage of vehicles and provide insights into consumer valuation of different vehicle attributes. The results of this project will shed light on the effects of many policies to reduce emissions from the light duty fleet.

- 6) "PIsCES: the Personal InterActive Eco-driving System," University of California, Davis, \$297,783, Proposal No. 2740-273

The AB 32 Scoping Plan points out that significant reductions in GHG emissions from transportation are necessary to reach the State's GHG reduction goals for 2020 and beyond. ARB is pursuing passenger-vehicle related GHG emissions reductions through various policies, but the Scoping Plan specifically mentions "eco-driving" as a key strategy that individual drivers can employ to reduce emissions and save money. Additional research is needed to understand how to effectively foster and sustain eco-driving, and to estimate the likely emissions reductions that would result from widespread adoption of eco-driving behavior in passenger vehicles.

The investigators will research the fuel economy and VMT impacts of driver feedback systems in personal vehicles by employing an eco-driving smartphone "app" designed for the open source Android phone operating system. Researchers will examine the effect of in-vehicle feedback (delivered through the driver's Android phone) on driver behavior for a full year on a sample of 500 households. Researchers will determine the effects of the feedback on fuel economy and VMT, and will examine the role of putting the feedback into various personal and social contexts by comparing driver behavior to personal goals or to the behavior of other drivers. This research will also test the effectiveness of visual versus auditory feedback, and will record the persistence of any observed driving behavior changes during the period of study. This project will quantify the effect of eco-driving feedback delivered through Android smartphones and the existing cellular network on a large study sample, and will estimate both the potential for market penetration of the eco-driving "app", and the cost of expanding this type of feedback system statewide.

- 7) "Effects of Complete Streets on Travel Behavior," University of California, Los Angeles, \$200,000, Proposal No. 2741-273

The Complete Streets Act (Assembly Bill 1358), which was signed into law in September of 2008, requires cities and counties to account for the needs of all roadway users when updating their local general transportation plan. Also, the California Department of Transportation (CalTrans) revised an internal policy to adopt a Complete Streets Implementation Action Act (2008). As a result, California became the second state to implement a Complete Streets policy by

designing roadways that are compatible to all types of transportation, including walking and cycling, as well as private vehicles and public transportation, with the goal of reducing the number of VMT and their associated emissions. So far, there is little evidence on whether and how complete streets result in changes in travel behavior such as reductions in VMT. Although there has been active research on the relationship between the built environment and travel behavior, most of the studies tend to focus on a larger scale of the built environment such as land-use density and street networks. Traffic engineering studies, on the other hand, focus mostly on individual road design elements and their traffic flow impact. Currently, there is little research on how complete street designs impact travel behavior. Therefore, the goal of this project is to collect information in Southern California on the impacts of complete streets on travel behavior, including how such impacts would differ among different population groups and across different land use contents (e.g. downtown business districts, urban mixed-use areas, and suburban residential areas) in roadways selected to represent typical arterial and local road types. This study will use two different designs, one will examine before-after comparisons by taking advantage of the conversion of an existing corridor to a complete street, and the other design will use six pairs of complete and incomplete streets matched to reduce differences in community location and socio-demographics. Both designs will evaluate the effectiveness of complete streets on local travel behaviors for different land-use contexts using traffic counts of all motorized and non-motorized travel modes and surveys to measure travel behavior changes. The results of this study will help to determine the effectiveness of complete streets conversions on the reduction in VMT. The study will quantify the effects of complete streets on travel behavior, as well as providing some information on barriers to changes in travel behavior. This information will help ARB in advising urban planners on complete streets designs that encourage the usage of active and public transportation.

- 8) "Analyzing the Economic Benefits and Costs of Smart Growth Strategies," University of California, Berkeley, \$300,000, Proposal No. 2742-273

To achieve the regional GHG emission reduction targets required by SB 375, (Sustainable Communities and Climate Protection Act of 2008), local governments and landowners must implement the smart growth plans developed and adopted by regional planning organizations. Therefore, the success of SB 375 is subject to decisions made by local land use authorities and local developers. Incentives have been introduced to influence these decisions, and more are planned, but their effectiveness is unproven.

This project will estimate the economic costs and benefits of implementing smart growth plans and projects, both from a regional perspective and from the perspectives of local agencies and other interest groups. It will do so by studying cases of smart growth strategies implemented in California. The purpose of the project is to clarify which smart growth strategies work best from a benefit-cost perspective in different land use and planning contexts, and to inform the design of municipal incentives to promote those strategies.

IV. Discussion of Draft Final Reports:

- 1) "Effects of Ozone Exposure on Cardiovascular Responses in Healthy and Susceptible Humans," University of California, San Francisco, \$399,029, Contract No. 04-322

Recent epidemiologic studies report associations between O₃ exposure and increased risk of cardiovascular morbidity and mortality. While several biological mechanisms that mediate respiratory-related effects of O₃ exposure are known, no biological mechanisms have been identified for cardiovascular effects. Decreased heart rate variability (HRV) is a well-known risk factor for adverse cardiovascular outcomes that can be non-invasively measured in human subjects. Other pathways that have been proposed include coagulability, and inflammation in the lungs and/or systemically. The objective of this project was to investigate these plausible biological pathways through which O₃ could alter cardiovascular function in healthy and asthmatic adults who each completed exposures to 100 and 200 ppb O₃, and filtered air. Each exposure lasted for four hours, and included intermittent exercise.

The investigators found that filtered air exposure with intermittent moderate-intensity exercise induced a pro-inflammatory systemic response, but no significant changes in HRV. Exposure to 200 ppb O₃, with exercise, induced a decrease in lung function, airway injury, and airway inflammation. Exposure to 100 ppb O₃ with exercise caused no decrease in lung function, only mild airway inflammation, and a small non-significant reduction in HRV. There was little evidence of a systemic inflammatory response related to either O₃ exposure, nor was there evidence of a pro-coagulatory response to O₃ exposure. However, despite this lack of a systemic response, exposure to 200 ppb O₃ induced changes in two parameters of HRV that had a dose response pattern, suggesting that O₃ exposure may influence HRV. The results of this project address a gap in our understanding of the biological basis for epidemiologic findings that O₃ exposure can induce adverse cardiovascular effects.

- 2) "In-Vehicle Air Pollution Exposure Measurement and Modeling," University of California, Irvine, \$500,000, Contract No. 07-310

On-road concentrations of traffic-related pollutants are typically much higher than the concentrations measured at ambient monitoring stations. Moreover, large numbers of Californians receive a significant proportion of their air pollution exposures during their commute time. However, there are many factors that determine in-vehicle exposures. While in-vehicle exposures are frequently as high as on-road outdoor concentrations, under conditions of low in-vehicle air exchange rate (AER), certain air pollutants, such as PM, can have concentrations that are significantly lower in the vehicle than those found outside the vehicle. The main purpose of this study was to collect in-vehicle air pollution data in Southern California, and develop and validate in vehicle exposure models. In this study a large sample of vehicles representative of the current California fleet was tested for in-vehicle AERs at various speeds. The study

found that AER is predictable based on vehicle age or mileage, speed, and the ventilation setting used (outside air, recirculation, or open windows). AER was found to be the dominant factor in determining the inside/outside ratio for pollutants such as ultrafine particles (UFP). Models were developed that explained over 80 percent of the variability in AER and UFP inside/outside ratios, within the California fleet and across the expected range of normal driving conditions. To better determine on-road outdoor concentrations, extensive on-road measurements were conducted using a mobile platform hybrid vehicle with real-time instrumentation. Models were developed and validated to estimate on-road traffic-related pollutant concentrations that can be combined with information about the vehicle, ventilation choices, and commute route of subjects to estimate in-vehicle exposures. The models developed from this research will facilitate the estimation of in-vehicle air pollutant exposures. These models use information that can be gathered in large part by questionnaires and GIS-based exposure assessment methods. It is expected that the models developed will help to predict in-vehicle exposure with sufficient accuracy for large epidemiologic studies of chronic disease outcomes and can also support emission regulations for vehicles and effective pollution control strategies.

V. Other Business:

- 1) "ARB Staff Update on Annual Research Plan"